July 26, 2018

Docket No. 52-048

U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
One White Flint North
11555 Rockville Pike
Rockville, MD 20852-2738

SUBJECT: NuScale Power, LLC Response to NRC Request for Additional Information No. 410 (eRAI No. 9310) on the NuScale Design Certification Application

REFERENCES:
1. U.S. Nuclear Regulatory Commission, "Request for Additional Information No. 410 (eRAI No. 9310)," dated April 09, 2018
2. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 410 (eRAI No. 9310)," dated June 08, 2018
3. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 410 (eRAI No. 9310)," dated June 20, 2018
4. NuScale Power, LLC Supplemental Response to NRC "Request for Additional Information No. 410 (eRAI No. 9310)," dated July 19, 2018

The purpose of this letter is to provide the NuScale Power, LLC (NuScale) response to the referenced NRC Request for Additional Information (RAI).

The Enclosures to this letter contain NuScale's response to the following RAI Question from NRC eRAI No. 9310:

- 03.09.02-62

The schedule for questions 03.09.02-69, 03.09.02-70 and 03.09.02-71 were provided in emails to NRC (Greg Cranston) dated May 09, 2018 and July 6, 2018.

Enclosure 1 is the proprietary version of the NuScale Response to NRC RAI No. 410 (eRAI No. 9310). NuScale requests that the proprietary version be withheld from public disclosure in accordance with the requirements of 10 CFR § 2.390. The enclosed affidavit (Enclosure 3) supports this request. Enclosure 2 is the nonproprietary version of the NuScale response.

This letter and the enclosed responses make no new regulatory commitments and no revisions to any existing regulatory commitments.

If you have any questions on this response, please contact Marty Bryan at 541-452-7172 or at mbryan@nuscalepower.com.

Sincerely,

Zackary W. Rad
Director, Regulatory Affairs
NuScale Power, LLC

Distribution: Gregory Cranston, NRC, OWFN-8G9A
Samuel Lee, NRC, OWFN-8G9A
Marieliz Vera, NRC, OWFN-8G9A

Enclosure 1: NuScale Response to NRC Request for Additional Information eRAI No. 9310, proprietary

Enclosure 2: NuScale Response to NRC Request for Additional Information eRAI No. 9310, nonproprietary

Enclosure 3: Affidavit of Zackary W. Rad, AF-0718-61095

Enclosure 1:

NuScale Response to NRC Request for Additional Information eRAI No. 9310, proprietary

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Enclosure 2:

NuScale Response to NRC Request for Additional Information eRAI No. 9310, nonproprietary

NUSCALE™
Power for all humankind

Response to Request for Additional Information
Docket No. 52-048

eRAI No.: 9310
Date of RAI Issue: 04/09/2018

NRC Question No.: 03.09.02-62
In the response to Subquestion 2 and 3 of RAI 8911, Question 03.09.02-27, the applicant stated that Belleville washers are placed below the lower core plate to tune the core's vertical natural frequency away from high vertical NPM acceleration frequencies that has peak near 17 Hz. A target core vertical frequency of 6 Hz was selected. To achieve the target frequency, the combined spring constant of the 10 Belleville washers acting in series at each core support block was calculated to be 106,800 lbf/in. However, EC-A010-2322-R2, "Reactor Module Seismic Model" Section 2.1.5 stated that four Belleville washers are assumed to exist at bottom of core support with spring constant of 1.068E5 lbf/in for each of the four washers. The staff is not clear how the combined spring constant of 106,800 lbf/in is obtained for the 10 Belleville washers acting in series. Provide the following information:

1. Spring constant for each of the 10 Belleville washers acting in series and the formula used in calculation of the combined spring constant of 106,800 lbf/in.
2. Clarify that the Design in-structure response spectra (ISRS) of the top and lower core plates (Fig. B16 to Fig. 21 in TR-0916-51502) are calculated from the NPM seismic model with 10 Belleville washers in series, not 4 Belleville washers in series, below the lower core plate.

Include the requested information in the NPM Seismic Report.

NuScale Response:

The Belleville washers in the lower reactor internals have been removed from the NuScale design. Therefore, these questions are no longer applicable. The Belleville washers were removed from the design because an artificial acoustic resonance that significantly increased loads in the reactor vessel internals was isolated. The artificial resonance was caused by an assumption of complete reflection of acoustic waves in the reactor pool at the reactor pool floor, when in reality the energy is partially reflected and partially absorbed. After performing a detailed modeling of the fluid-structure interaction, the artificial resonance was eliminated, and the seismic Belleville washers became no longer necessary.

The core support block attachment configuration for the lower reactor internals is shown in Figure 1. The Belleville washers have been replaced with socket head cap screws and shear pins, that provide a circumferential and vertical restraint. The interfacing slotted holes on the lower core plate permit relative thermal growth of core support and lower RPV. The radial direction restraint is therefore released in the NPM seismic model.

{{

}}2(a),(c)

Figure 1 Core support blocks and attachment hardware

An update to the NuScale Power Module Seismic Analysis Technical Report, TR-0916-51502, Revision 1, will be submitted reflecting the seismic Belleville washer deletion. Specifically, TR

Sections 3.11, 4.1.1.2, and 4.1.3.3 remove discussion of the Belleville washers and add a detailed description of the revised fluid-structure interaction modeling.

The relevant sections of the FSAR have also been revised to remove the Belleville washers, as included with this RAI response.

Impact on DCA:

The FSAR Tier 2 Section 3.9.5 and Figure 3.9-4, Section 4.5.2 and Table 4.5-2, and Section 5.2 Table 5.2-7 have been revised as described in the response above and as shown in the markup provided with this response.

RAI 04.05.02-2, RAI 05.04.02.01-6

Table 5.2-7: Reactor Vessel Internals Inspection Elements

Description	Location	Examination Category	Examination Method	Notes
Core Support Components				
Reflector Block - Bottom	Core Support Assembly	B-N-3	VT-3	
Reflector Block Intermediate	Core Support Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1. Exam will be of the interior surface, checking for a gap developing between reflector blocks.
Reflector Block Top	Core Support Assembly	B-N-3	VT-3	
Reflector Block Alignment Pins	Core Support Assembly	B-N-3	VT-1	Inspection only required when reflector blocks are removed for another reason
Core Barrel	Core Support Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1 of accessible surfaces
Lower core Plate	Core Support Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1 of accessible surfaces
Upper Core Plate	Lower Riser Assembly	B-N-3	VT-3	
Lower Core Plate Alignment Pins	Core Support Assembly	B-N-3	VT-3	
Upper Support Block	Core Support Assembly	B-N-2	VT-1	
Core Barrel to Lower Core Plate	Core Support Assembly	B-N-2	VT-1	
Fuel Pins	Lower Riser Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1
Fuel Pins Caps	Lower Riser Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1
Fuel Pin Capture Weld	Lower Riser Assembly	B-N-2	VT-1	
Shared Fuel Pins and Nuts	Core Support Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1
Lower Riser to Upper Core Plate	Lower Riser Assembly	B-N-3	VT-3	
ICIGT Bottom Flag ICIGT 1 to Upper Core Plate	Lower Riser Assembly	B-N-3	VT-1	Required VT-3 augmented to VT-1
~~Upper Seismic Belleville Washers~~	~~Core Support Assembly~~	~~B-N-3~~	~~VT-3~~	
~~Lower Seismic Belleville Washers~~	~~Core Support Assembly~~	~~B-N-3~~	~~VT-1~~	~~VT-1 measurement of the lower core plate height relative to the core support block~~
~~Upper Seismic Belleville Retaining Nut~~	~~Core Support Assembly~~	~~B-N-3~~	~~VT-3~~	

- GDC 4, as it relates to reactor internals; reactor internals are designed to accommodate the effects of and to be compatible with the environmental conditions associated with normal operations, maintenance, testing, and postulated pipe ruptures, including LOCA. Dynamic effects associated with postulated pipe ruptures such as guillotine breaks of primary piping that cause asymmetric loading effects are excluded from the design basis when analyses demonstrate that the probability of fluid system piping rupture is extremely low under conditions consistent with the design basis for the piping. The only RCS structures and components that require protection against the effects of pipe whipping and discharge fluids are those that are in the proximity of high and moderate energy piping between the RPV and the CNV. Additionally, the leak-before-break methodology is applied as described in Section 3.6
- GDC 10, as it relates to reactor internals; reactor internals are designed with appropriate margin to assure that specified acceptable fuel design limits are not exceeded during any condition of normal operation, including the effects of AOOs. For further details on compliance, see Section 3.1.2

3.9.5.1 Design Arrangements

Figure 3.9-1 through Figure 3.9-4 show the RVI subassemblies with components that comprise the RVI.

The overall RVI assembly is depicted in Figure 3.9-1. (Note the SG tube bundles which reside in the annulus between the upper riser assembly and the RPV upper shell are not depicted in this figure). The CSA is located near the bottom of the RPV, below the RPV flange. Above the CSA are the lower riser assembly and upper riser assembly. During disassembly, the CSA and lower riser assembly stay with the lower NPM and the upper riser assembly stays attached to the upper NPM. Each of the RVI sub-assemblies is described in more detail below.

The CSA (Figure 3.9-4) includes the core barrel, upper support blocks, lower core plate, lower fuel pins and nuts, reflector blocks, lock plate assembly, lower core support lock inserts, and the RPV surveillance specimen capsule holder and capsules.

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The core barrel is a continuous ring with no welds. The upper support blocks, which are welded to the core barrel, serve to center the core barrel in the lower RPV. In addition, one of the upper support blocks engages a core barrel guide feature on the lower RPV to provide circumferential positioning of the core barrel as it is lowered into the lower RPV. The lower core plate, which is welded to the bottom of the core barrel serves to support and align the bottom end of the fuel assemblies. ~~Stacks of seismic Belleville washers (see Figure 3.9-4) embedded in the lower core support blocks provide upward vertical support for the lower core plate. Downward vertical restraint on the lower core plate is provided by smaller stacks of seismic Belleville washers held down by retaining nuts on studs that protrude from the lower core support blocks. These studs also provide the horizontal support for the lower core plate.~~ The lower core support blocks are located on the RPV bottom head.

The reflector blocks contain no welds. The reflector blocks are aligned by reflector block alignment pins and stacked on the lower core plate inside the core barrel. The cold condition, on the lower riser interface, and then allows for the vertical thermal expansion. The RVI materials including base materials and weld filler materials are discussed in Section 4.5.2 and are designed to minimize the number of welds and bolted interfaces within the high neutron flux regions.

During refueling and maintenance outages the upper riser assembly stays attached to the upper section of the NPM (upper CNV, upper RPV and SG) while providing physical access for potential inspection of the feedwater plenums, SG, RPV and control rod drive shaft supports. The lower riser assembly and CSA remain with the lower NPM (lower CNV, lower RPV, core barrel, and core plates) when the module is parted for refueling and maintenance.

The RVI upper riser assembly is supported from the RPV integral steam plenum (e.g., below the bottom of the PZR).

RAI 03.09.02-62, RAI 03.09.05-4, RAI 03.09.05-12

Under normal operation, the reactor core is supported by the core support structures of the CSA (~~seismic Belleville washers,~~ core support blocks, core barrel, lower core plate and upper core plate) that surround the fuel assemblies. The deadweight and other mechanical and hydraulic loads from the fuel are transferred to the upper and lower core plates. The motion of the upper and lower core plates is coupled through the core barrel. Under seismic and other accident conditions, the core barrel transfers lateral loads to the RPV shell through the core support blocks at the bottom of the RPV and the upper support blocks that are attached to the upper portion of the core barrel. The vertical loads are transferred from the core barrel to the RPV head through the ~~seismic Belleville washers and~~ core support blocks.

The fuel is surrounded by a heavy neutron reflector made of reflector blocks stacked on top of each other. The heavy reflector reflects neutrons back into the core to improve fuel performance. The heavy reflector provides the core envelope and directs the flow through the core. Under normal operation the heavy reflector does not provide support to the core and performs as an internal structure. During seismic and other accident events the heavy reflector limits the lateral movement of the fuel assemblies and transfers those loads to the core barrel.

A set of upper CRDM supports in the upper riser assembly, in conjunction with the CRA guide tube support plate, CRA guide tubes, and upper core plate in the lower riser assembly properly align and provide lateral support for the CRAs. The clearances provided at all these supporting members are intended to ensure adequate alignment of the CRDS with the fuel assemblies and permit full insertion of control rods under all design basis events (DBEs).

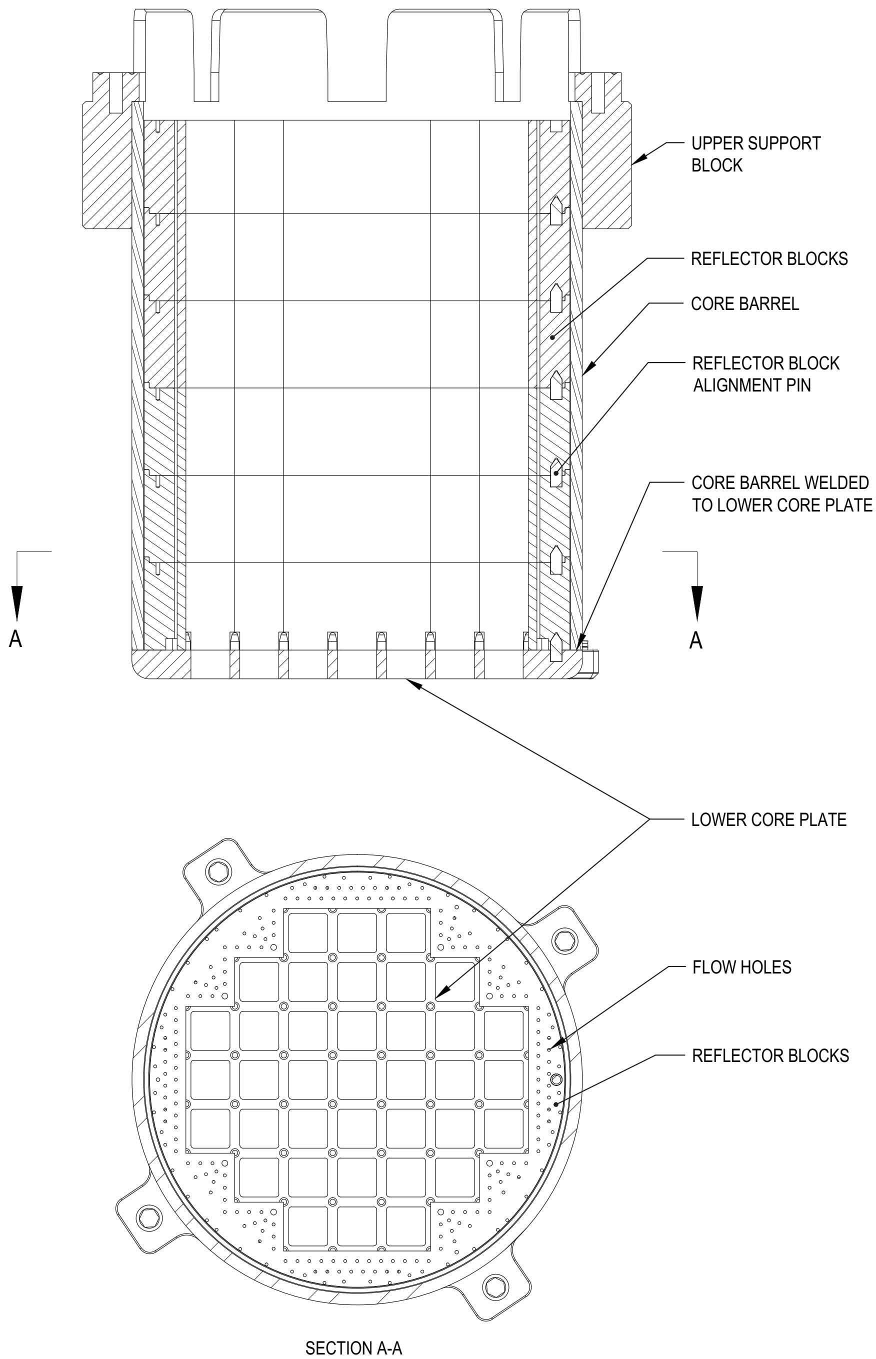
3.9.5.2 Loading Conditions

Design, construction, and testing of the RVI core support structures and internal structures are in accordance with ASME BPVC Section III, Division 1, Subsection NG.

Section 3.6.2 provides determination and evaluation of pipe rupture locations and loads, and includes dynamic effects of postulated rupture of piping. Section 3.9.1

RAI 03.09.02-62

Figure 3.9-4: Core Support Assembly



Part D, Tables 2A, 2B, and 4. The remaining portions of the RVI are designated as internal structures and are designed to conform to ASME BPV Code, Section III, Article NG-3000 considering the requirements of Paragraph NG-1122(c).

RAI 03.09.02-62, RAI 04.05.02-2

The design of RVI has considered peak neutron fluence in the materials surrounding the core. Neutron irradiation-induced degradations such as irradiation-assisted stress corrosion cracking, void-swelling, stress-relaxation, and irradiation embrittlement have been evaluated using material aging degradation mechanism screening criteria of the Electric Power Research Institute (EPRI) materials reliability program (Reference 4.5-3). The components meeting the screening criteria are the incore instrumentation guide tube (ICIGT) flags and welds, fuel pins and caps, shared fuel pins and nuts, the intermediate reflector blocks and alignment pins, the lower core plate, and the core barrel, and the lower seismic Belleville washers. In addition, components identified as susceptible to irradiation-induced stress relaxation are also included for potential wear due to loosening. Components screening in for neutron degradation are included for augmented visual inspection.

4.5.2.2 Control on Welding

The welding of RVI materials conform to the applicable requirements of ASME BPV Code, Section III, Articles NG-2000, NG-4000, and NG-5000. Welding is conducted utilizing procedures qualified according to the rules of ASME BPV Code, Sections III, Subarticle NG-4300 and Section IX. Welders and welding operators are qualified in accordance with ASME BPV Code Section IX and RG 1.71, Revision 1.

Electroslag welding is not permitted on RVI and core structural supports. Additional information regarding welding of austenitic stainless steel RCPB materials provided in Section 5.2.3 is also applicable to the welding of RVI and core support components.

4.5.2.3 Nondestructive Examination

Nondestructive examinations of core support structure materials, including tubular products, conform to the requirements of ASME BPV Code, Section III, Subarticle NG-2500 utilizing the methods of ASME BPV Code, Section V and acceptance standards of Subarticle NG-5300.

4.5.2.4 Fabrication and Processing of Austenitic Stainless Steel Components

Most RVI base metal is fabricated from Type 304/304L austenitic stainless steel. The locking assembly studs are composed of austenitic stainless steel XM-19. Austenitic stainless steel parts are fabricated from materials procured in the solution-annealed condition. Use of cold worked austenitic stainless steel is avoided to the extent practicable during fabrication of the RVI and core support structure. Austenitic stainless steel used in the RVI and core support components does not exceed a yield strength of 90,000 psi as determined by the 0.2 percent offset method.

Processing and welding of unstablized AISI Type 3XX series austenitic stainless steels comply with RG 1.44 to prevent sensitization and stress-corrosion cracking. When

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~~The seismic Belleville washers that support the lower core plate are nickel-based SB-637, Grade 688, Type 3. This material is allowed for use as a core support material by Code Case N-60-5.~~

RAI 04.05.02-1

Washers used in the RVI upper riser assembly are nickel-based Alloy 718. These washers utilize the same final solution annealing and precipitation-hardening treatment process as used for Alloy 718 threaded fasteners. Refer to Section 3.13.1 for further discussion regarding the annealing and precipitation-hardening treatment for Alloy 718 materials. The RVI upper riser assembly washers are not in tension and, as a result, they are not susceptible to stress corrosion cracking.

4.5.3 References

4.5-1 American Society for Testing and Materials, “Standard Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels,” ASTM A262-15, West Conshohocken, PA, September 2015.

4.5-2 American Society of Mechanical Engineers, "Quality Assurance Requirements for Nuclear Facility Applications," ASME NQA-1-2008/1a-2009 Addenda, New York, NY.

4.5-3 Electric Power Research Institute, "Materials Reliability Program: PWR Internals Material Aging Degradation Mechanism Screening and Threshold Values (MRP-175)," EPRI Technical Report 1012081, Palo Alto, CA, December 2005.

4.5-4 Electric Power Research Institute, "Materials Reliability Program: Resistance to Primary Water Stress Corrosion Cracking of Alloys 690, 52, and 152 in Pressurized Water Reactors (MRP-111)," EPRI Technical Report 1009801, Palo Alto, CA, U.S. Department of Energy, Washington, DC, March 2004.

4.5-5 Electric Power Research Institute, "Materials Reliability Program: Resistance to Primary Water Stress Corrosion Cracking of Alloy 690 in Pressurized Water Reactors (MRP-258)," EPRI Technical Report 1019086, Palo Alto, CA, U.S. Department of Energy, Washington, DC, August 2009.

RAI 03.09.02-62

Table 4.5-2: Reactor Vessel Internal Materials

Component	Specification	Material Designation (Grade, Class, or Type)
Core Support Assembly		
Core barrel	SA-965	Type 304/304L; Grade F304/F304L
Reflector blocks	SA-965 or SA-182	Type 304/304L; Grade F304/F304L
Lower core plate	SA-965 or SA-240	Type 304/304L
Alignment pins for reflectors Shared fuel pin and fuel pin nuts	SA-479	Type 304/304L
Alignment pins for lower core plate	SA-193	Type 304; Grade B8
Upper support blocks	SA-479 or SA-240	Type 304/304L
Core Support Locking Assembly		
Locking plates	SA-240	Type 304/304L
Spacers	SA-479	Type 304/304L
Spherical bearing ball	N/A	Stellite 3 cast or Low cobalt or cobalt-free material
Set screws, nuts, washers, locking Belleville washers	SA-193	Type 304; Grade B8
Check ball retainer	SA-564	Type 17-4 (UNS S17400); Grade 630; Condition H1100
Studs	SA-479	Type XM-19
~~**Seismic Belleville Washer Assembly**~~		
~~Upper and lower seismic Belleville washers~~	~~SB-637~~	~~Grade 688, Type 3~~
~~Seismic Belleville retaining nut, seismic Belleville retaining pin~~	~~SA-193~~	~~Grade B8~~
Reactor Vessel Surveillance Capsule Assembly		
Capsule basket, protection guide, support Specimen enclosure Screw locking caps	SA-240	Type 304/304L
Plugs and dowel pins Screws	SA-479	Type 304/304L
Upper Riser Assembly		
Upper riser transition and section Riser backing strips Upper CRD supports Upper riser hanger ring and hanger braces Chemical volume and control system (CVCS) injection piping support Incore instrumentation centering plate Flow diverter	SA-240	Type 304/304L
Upper riser hanger threaded structural fasteners Upper riser hanger alignment pins	SA-479	Type 304
Upper riser bellows CVCS injection flexible pipe	N/A	Type 304L
CVCS injection piping	SA-312	Seamless; Grade TP304/TP304L
CVCS injection piping end cap CVCS injection piping elbow	SA-182	Grade F304/F304L
Incore instrumentation guide tubes (ICIGTs) - 1-12	SA-213	Grade TP304/TP304L
Pressurizer spray nozzles	SA-479	Grade TP304/TP304L
Washers	SB-637	Alloy 718 (UNS N07718)

Enclosure 3:

Affidavit of Zackary W. Rad, AF-0718-61095

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NuScale Power, LLC

AFFIDAVIT of Zackary W. Rad

I, Zackary W. Rad, state as follows:

1. I am the Director, Regulatory Affairs of NuScale Power, LLC (NuScale), and as such, I have been specifically delegated the function of reviewing the information described in this Affidavit that NuScale seeks to have withheld from public disclosure, and am authorized to apply for its withholding on behalf of NuScale.
2. I am knowledgeable of the criteria and procedures used by NuScale in designating information as a trade secret, privileged, or as confidential commercial or financial information. This request to withhold information from public disclosure is driven by one or more of the following:
   a. The information requested to be withheld reveals distinguishing aspects of a process (or component, structure, tool, method, etc.) whose use by NuScale competitors, without a license from NuScale, would constitute a competitive economic disadvantage to NuScale.
   b. The information requested to be withheld consists of supporting data, including test data, relative to a process (or component, structure, tool, method, etc.), and the application of the data secures a competitive economic advantage, as described more fully in paragraph 3 of this Affidavit.
   c. Use by a competitor of the information requested to be withheld would reduce the competitor's expenditure of resources, or improve its competitive position, in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product.
   d. The information requested to be withheld reveals cost or price information, production capabilities, budget levels, or commercial strategies of NuScale.
   e. The information requested to be withheld consists of patentable ideas.
3. Public disclosure of the information sought to be withheld is likely to cause substantial harm to NuScale's competitive position and foreclose or reduce the availability of profit-making opportunities. The accompanying Request for Additional Information response reveals distinguishing aspects about the method by which NuScale develops its power module seismic analysis.

   NuScale has performed significant research and evaluation to develop a basis for this method and has invested significant resources, including the expenditure of a considerable sum of money.

   The precise financial value of the information is difficult to quantify, but it is a key element of the design basis for a NuScale plant and, therefore, has substantial value to NuScale.

   If the information were disclosed to the public, NuScale's competitors would have access to the information without purchasing the right to use it or having been required to undertake a similar expenditure of resources. Such disclosure would constitute a misappropriation of NuScale's intellectual property, and would deprive NuScale of the opportunity to exercise its competitive advantage to seek an adequate return on its investment.

4. The information sought to be withheld is in the enclosed response to NRC Request for Additional Information No. 410, eRAI No. 9310. The enclosure contains the designation "Proprietary" at the top of each page containing proprietary information. The information considered by NuScale to be proprietary is identified within double braces, "{{ }}" in the document.
5. The basis for proposing that the information be withheld is that NuScale treats the information as a trade secret, privileged, or as confidential commercial or financial information. NuScale relies upon the exemption from disclosure set forth in the Freedom of Information Act ("FOIA"), 5 USC § 552(b)(4), as well as exemptions applicable to the NRC under 10 CFR §§ 2.390(a)(4) and 9.17(a)(4).
6. Pursuant to the provisions set forth in 10 CFR § 2.390(b)(4), the following is provided for consideration by the Commission in determining whether the information sought to be withheld from public disclosure should be withheld:
    a. The information sought to be withheld is owned and has been held in confidence by NuScale.
    b. The information is of a sort customarily held in confidence by NuScale and, to the best of my knowledge and belief, consistently has been held in confidence by NuScale. The procedure for approval of external release of such information typically requires review by the staff manager, project manager, chief technology officer or other equivalent authority, or the manager of the cognizant marketing function (or his delegate), for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside NuScale are limited to regulatory bodies, customers and potential customers and their agents, suppliers, licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or contractual agreements to maintain confidentiality.
    c. The information is being transmitted to and received by the NRC in confidence.
    d. No public disclosure of the information has been made, and it is not available in public sources. All disclosures to third parties, including any required transmittals to NRC, have been made, or must be made, pursuant to regulatory provisions or contractual agreements that provide for maintenance of the information in confidence.
    e. Public disclosure of the information is likely to cause substantial harm to the competitive position of NuScale, taking into account the value of the information to NuScale, the amount of effort and money expended by NuScale in developing the information, and the difficulty others would have in acquiring or duplicating the information. The information sought to be withheld is part of NuScale's technology that provides NuScale with a competitive advantage over other firms in the industry. NuScale has invested significant human and financial capital in developing this technology and NuScale believes it would be difficult for others to duplicate the technology without access to the information sought to be withheld.

I declare under penalty of perjury that the foregoing is true and correct. Executed on July 26, 2018.

Zackary W. Rad